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VITAL DIAGNOSTICS METHOD FOR COWS' GONADS USING ULTRASOUND DATA AND DISCRIMINANT ANALYSIS

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ABSTRACT

Given article introduces and analyzes the results of ultrasound studies of cows' gonads (ovaries) in the normal and the pathological condition. The following parameters of the gonads were obtained: width, length, density, and presence of follicle. The diagnosis of gonads' diseases and categorization according to the certain parameters into individual groups was performed using a discriminate analysis method.

KEYWORDS: Reproductive Function, Gonads' Diseases, Ultrasound Diagnostic Methods, Discriminant Analysis

INTRODUCTION

Despite the rich variety of methods for controlling the processes of animals breeding, the issues of preventing cattle infertility and producing healthy breeds of cattle, remain one of the most important issues in veterinary science. Breeding of cattle depends on many factors, the most important factors are the normal functioning of the reproductive organs, and the other general organs systems of cows.

One of the essential reasons for disorder cows' reproductive function is gonads dysfunction (hypo trophy, atrophy, sclerosis, etc) [1, 2]. Today in veterinary science there are basic methods as (clinical, rectal, histological) and additional (ultrasound) methods for determining the functional state of the gonads [3, 4]. The advantage of ultrasound diagnosis, which is considered as additional but at the same time it is more informative method, as a vital investigating methods that described in [5, 6].

This diagnostic method allows us to study the structure of the organs and attain more complete, accurate, and visual data about the differences in the densities of the organ's structure. The ultrasound method also allows determination of the geometrical parameters of the organ and detection of pathological processes. However, to increase the probability of correct diagnosis is an actual and should be to developed additional methods analysis. One of the approaches is the processing of the ultrasound data using software (implementing as a discriminate analysis). This will allow the veterinarian to increase the probability of a correct diagnosis.

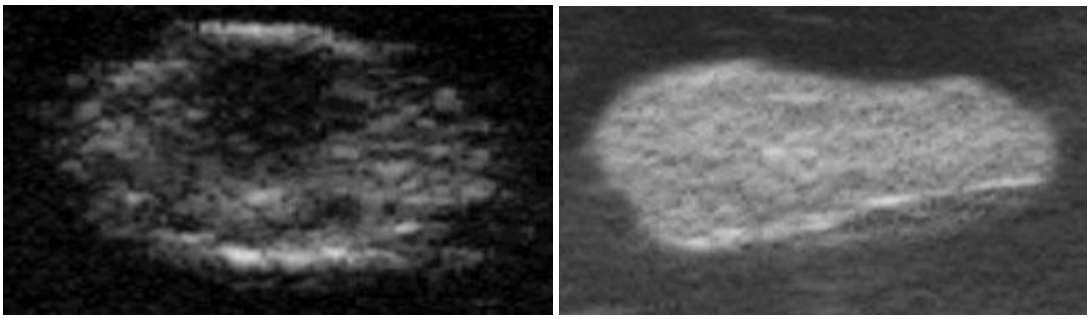
PROBLEM STATEMENT AND WORK OBJECTIVES

The goal of the study is to carrying ultrasound examinations and to obtaining parameters as (width, length, density, and follicles presence) of gonads, that to determine their status (normal or pathological), usually is to compaction organ structure. The obtained data for the pathology diagnosis will be done to separate them by their featured to different groups, the method of discriminate analysis will be applied.

MATERIALS AND STUDY METHODS

To obtain the required data and to achieve the objectives task. At the obstetrics department, the gynecology and

biotechnology of Kharkov State Academy of Animal Health, during the period of 2011 – 2013 were carried out all required examination of cows' gonads, by using an ultrasound diagnostic device SLE - 101 PC with a trans-rectal probe (Figure 1).



(a) **(b)**

Figure 1: Gonads' Scintiscans: (a) Normal, (b) Pathology (Hypofunction1st Stage)

As a result, of the study has been obtained 72 gonads' scintiscans: from them 32 – were in normal condition, 40 – with a pathology: 1st stage hypo function (10), 2nd stage hypo function (14), sclerosis (8), and atrophy (8). By using the above mentioned diagnostic device: we obtained scintiscans for the following gonads' parameters: width, length and number of follicles. For a more specific diagnosis the veterinarian needs to know the density of the gonads, because sealing structure of the organ's will cause in function disorder of the animal's reproduction system. Current SLE - 101 PC has no function for determining the organ density, so we developed a software for automatic processing of scintiscans that determining the density of the gonads in the normal condition and pathological condition. The results of these studies are shown in Table 1.

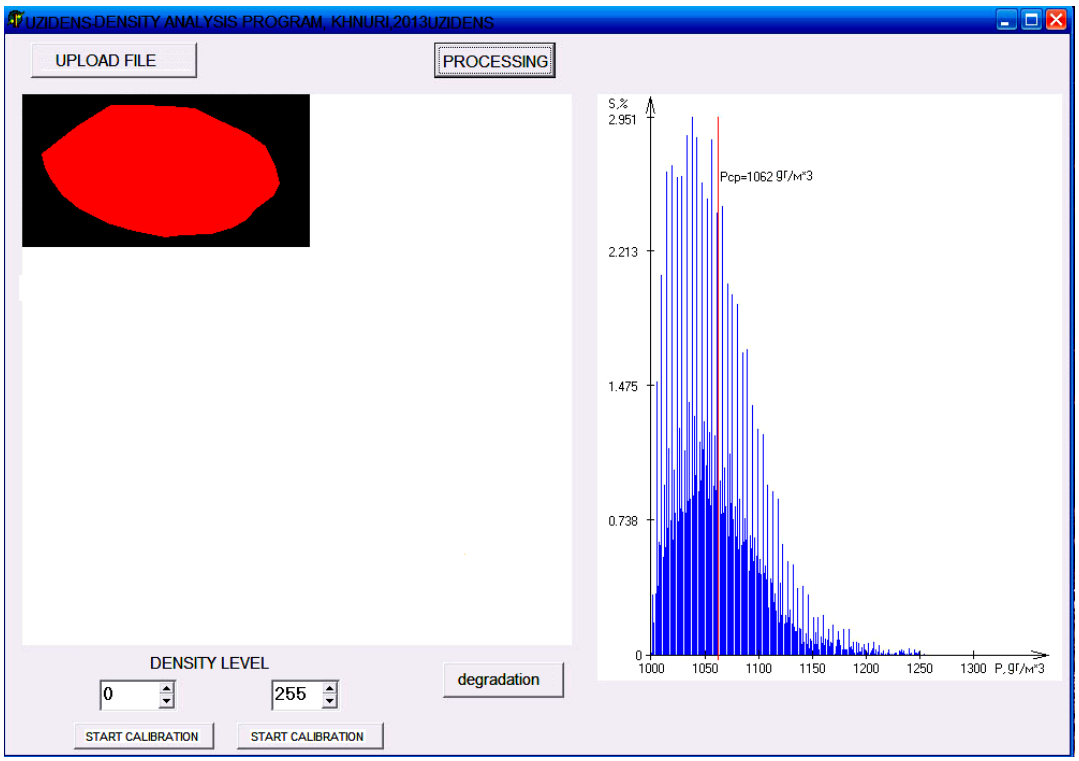


Figure 2a

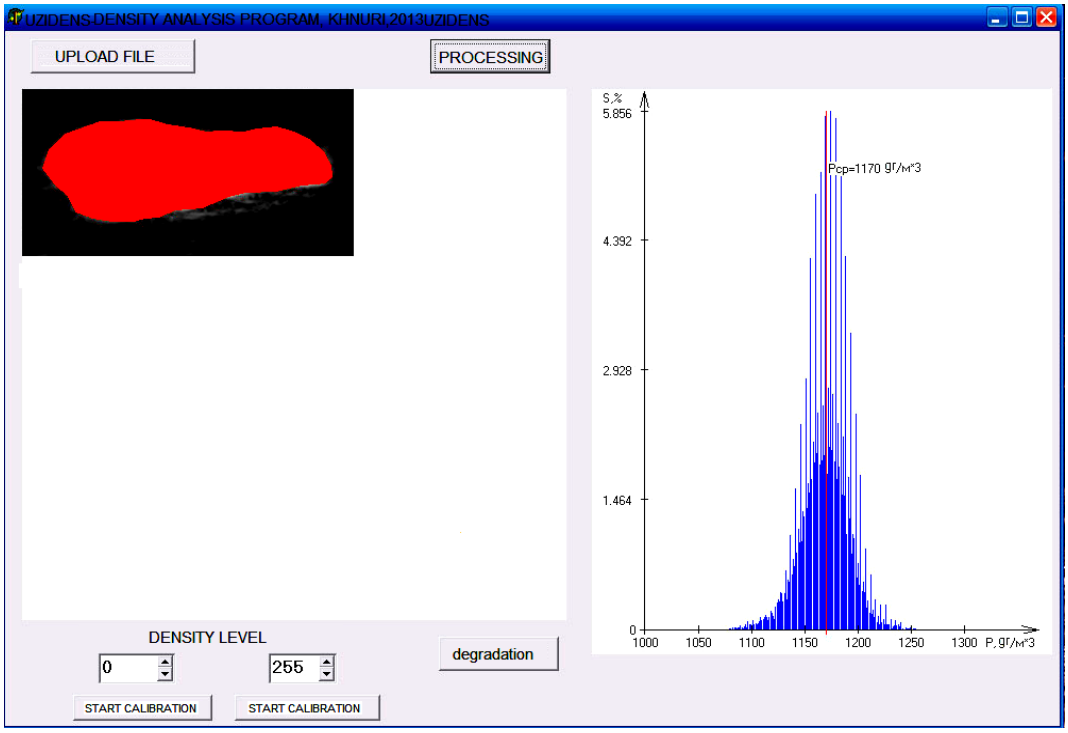


Figure 2b

Figure 2: The Interface of the Program to Determine the Density of the Gonads: a) Normal b) 1st Stage Hypothyroidism

Table 1: Results of Gonads Study

Diagnosis Result	Parameters (Average Value)			
	Width, mm	Length, mm	Density, kg/m^3	Number of Follicles
Normal	20,2	32,8	1058	13
1st stage Hypo function (n = 10)	13,8	18,5	1171	0
2nd stage Hypo function (n = 14)	15,7	31,5	1144,6	4,5
sclerosis (n = 8)	13	19,8	1233,5	0
atrophy (n = 8)	4,7	11	1161	0

A significant difference between the average values of the determined parameters for animals groups with in norm and different pathologies allows to apply the method of discriminate analysis for the diagnosis of various diseases and comparing them to the normal. The discriminate analysis was carried out according to the standard methods in [7-10].

The discriminate equation for comparing and select one of two types of disease (normal or disease) A_1 and A_2 for values of clinical parameters x_1, x_2, x_3, x_4 has the form:

$$X_{A_1A_2} = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 - X_{0A_1A_2},$$

Where $X_{A_1A_2}$ - is the discriminant function; a_1, a_2, a_3, a_4 are the discriminate coefficients; $X_{0A_1A_2}$ - is the parameter of boundary division for A_1 and A_2. Hereinafter we will use the following notation for A_1 and A_2 (obviously, $A_1 \neq A_2$): N– Normal; G– 1st stage Hypofunction; H– 2nd stage Hypofunction; C– Sclerosis; A– atrophy.

The values of the discriminate coefficients, for boundary division parameter, and the determination error (division or discrimination) in percentage for pair wise comparison of N, G, H, C and A are calculated using standard methods [7] by sample data as given in Table 2. For clarity, we constructed a corresponding diagram for the pair comparison of diseases with the determination error (Figure 3).

According to V. Urbach [7] to diagnose the disease (or its absence) all diseases are compared with one type, for example with normal condition N. thus, if all values of discriminate functions X_{NA_2} (where $A_2 =$ G, H, C or A) by substituting equation with the parameters in Table 1-3. 2 measured values indexes x_1, x_2, x_3, x_4 are in negative , that indicates the animal is in normal condition. If the values of X_{NA_2} have different signs, that indicates the animal with disease for which algebraic value X_{NA_2} is maximum.

But this is true only when animal samples are approximately of same size and are well separated from each other. In the case when it is not fall in this context, we proposed a consecutive pair comparison method for various diseases (and normal) in order to increase the reliability and reduce the error of the final diagnosis result. After comparison all diseases with the normal condition were compare with the 1st stage hypo function. If X_{NG} is positive and all of the discriminate functions X_{GA_2} (where $A_2 =$ H, C or A) in the equations with the parameters (5-7) in Table 2 are negative then 1st stage hypo function *G*. If the results had positive values X_{GA_2} so the further comparison is made with a 2nd stage hypo function H (discriminate equation with parameters (8-9) Table 2). If, while that all discriminate functions X_{HA_2} ($A_2 = C$ or *A*) are negative, and the previously obtained values of X_{NH} and X_{GH} are positive then the 2nd stage hypo function is diagnosed. If there is a positive value X_{HA_2} are detect, then a comparison is made with atrophy (discriminate equation with parameters 10 in Table 2). Thus, if the value of X_{AC} is negative and the previously obtained values of X_{NA}, X_{HA}, X_{GA}, and X_{CA} are positive, then atrophy is diagnosed. If all measured value X_{NC}, X_{HC}, X_{GC}, X_{CA} and X_{AC} are positive then sclerosis is diagnosed.

Table 2: The Results of Discriminate Analysis

No	Pair Comparisons	a_1	a_2	a_3	a_4	Boundary Division $X_{0A_1A_2}$	Determination Error %
1	NG	0,06	1,74	–2,24	–1,49	59,57	4,5
2	NH	0,21	0,72	–2,09	–3,24	191,34	0
3	NC	0,18	0,36	–0,53	0,97	211,64	1,4
4	NA	0,29	–0,22	1,23	–1,18	334,88	0
5	GH	0,03	1,17	–1,57	–0,32	33,33	0
6	GC	0,17	0,27	–0,43	–0,08	204,46	2
7	GA	0,9	2,61	–4,81	–5,44	1050,46	1,9
8	HC	0,18	0,26	–0,41	0,92	210,36	6,2
9	HA	0,34	–0,76	1,9	–1,59	393,47	9,2
10	CA	0,17	0,48	–0,88	–1,18	193,98	2,3

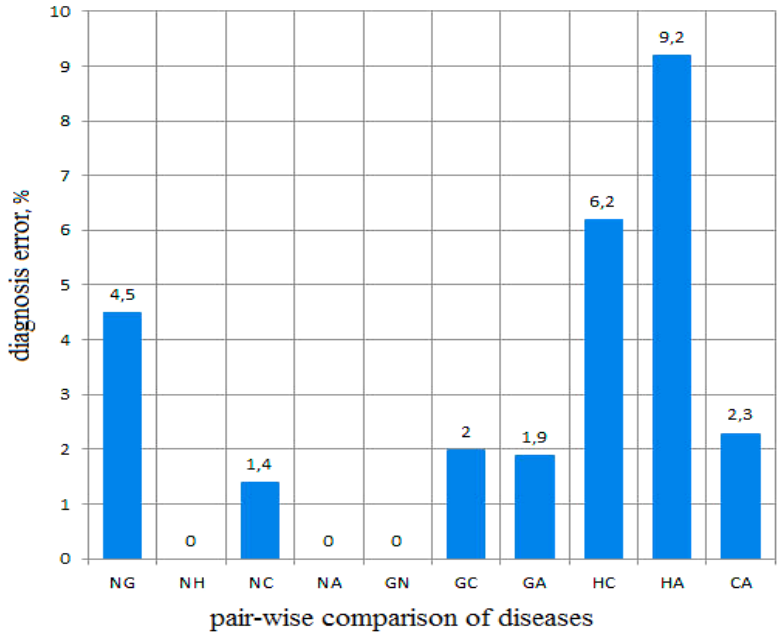


Figure 3: Dependency Diagram for Pair Comparison of Diseases with Determination Error

The proposed method is demonstrated in the following examples (Table 3). The table lists the clinical parameters of x_1, x_2, x_3, and x_4 for five animals. The calculated values of the discriminate functions and the final diagnosis are also represented in the table.

CONCLUSIONS

Applying the method of discriminate analysis on obtained ultrasound data we can conclude that the final diagnosis coincides with the study results. Diagnostic Error absence or the presence or disease determination of our suggested method of consecutive pair comparison does not exceed 9.2%. Thus, proposed methods of vital diagnosis of gonads can reliably diagnose cow gonads' pathology and can be used in conjunction with other vital diagnostic methods to increase the reliability and validity (accuracy) of the examination.

Table 3: Examples of Diagnostics

No	Parameters				The Values of the Discriminate Functions										Diagnosis
	x_1	x_2	x_3	x_4	X_{NG}	X_{NH}	X_{NC}	X_{NC}	X_{GH}	X_{GC}	X_{GA}	X_{HC}	X_{HA}	X_{CA}	
1	1030	30	20	12	– 11,7	– 35,4	– 14,8	–33,0	–	–	–	–	–	–	Normal condition
2	1181	15	13	0	4,4	38,8	–1,0	19,6	–6,4	–0,9	–8,9	–	–	–	Hypothyroidism 1st stage
3	1156	27	16	4	11,2	23,0	1,1	8,7	1,1	–3,7	–36,3	–2,8	–2,2	–	Hypothyroidism 2nd stage
4	1281	17	13	0	13,5	61,2	17,7	48,1	–1,6	17,0	86,5	53,5	14,9	14,9	sclerosis
5	1161	12	4	0	15,9	49,3	–1,4	4,6	2,1	–1,8	3,7	1,4	–4,4	–0,3	atrophy

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